Geomajas GWT face

Geomajas Developers and Geosparc
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Chapter 1. Introduction

The GWT face allows you to use Java code for development of your AJAX based GIS web applications. It uses Google Web Toolkit and the SmartGWT widget library to have powerful widget which look nice.

GWT is a toolkit from Google which is used amongst others for the development of Google AdWords and Google Wave. It compiles your Java code to JavaScript to allow the code to run on the client side, in the browser. While doing so, it takes care of many browser idiosyncrasies to alleviate the need to consider browser compatibility issues. GWT tries to make the user experience as comfortable as possible, to a large extent by focusing on responsiveness of the user interface. It combines all code and aggressively compresses that to reduce loading delays and allow caching. When the script file gets large, you still have the option to split it to reduce load time (the other parts are then loaded asynchronously. It also contains support for building internationalized applications, for combining resources etc.

For the developer, there is the ability to run your applications in development mode. Though this is slower than production mode, it does remove the need for the full compilation before application startup (a big improvement as GWT produces different code per browser and language pair), and what’s more, it allows debugging your application in Java!
Chapter 2. GWT face architecture

1. Client-server communication

Client-server communication in Geomajas is executed through a series of commands instantiated on the client and executed by the server. In the GWT face, all such commands are executed by `org.geomajas.gwt.client.command.GwtCommandDispatcher`. This class has one single method for instantiating such commands and handling the result: the `execute` method.

The command object, required by the execute method (`GwtCommand`), is in fact a wrapper around a `CommandRequest` object (see architecture), wherein the name of the requested command is found. Each command expects a certain implementation of the `CommandRequest` and `CommandResponse` objects. Note that these request and response objects must also be known server-side, and thus will not be packaged within the GWT client packages. As additional parameters for the execute method, `CommandCallback` objects can be passed. These can contain methods to call after successful or unsuccessful completion of the command. It is recommended to extend `AbstractCommandCallback` for your implementation.

The `GwtCommandDispatcher` is also the central access point for security in the GWT face. You should register a `TokenRequestHandler` to handle the login procedure if needed. You can read data about the current user when logged in.

Note

Note that insufficient authorizations can be difficult to debug. When no commands can be executed on the server, the logging on the server also fails. When logging in is done using a command, execution of that command needs to be allowed. Failure to configure the system to have minimal authorizations will likely cause your map to be invisible without any feedback.

2. The map's model

As with any GIS framework or application, the most crucial of all entities is the Map. A map is represented by the `org.geomajas.gwt.client.widget.MapWidget`, but is set up using the standard model-view-controller paradigm. The widget is the actual view of a map, with `Painter` objects building the display. The user interaction is handled using controllers, represented by the `GraphicsController` interface. The third aspect, the model, is represented by the `org.geomajas.gwt.client.map.MapModel`.

2.1. MapModel

The definition of the model behind a map (`org.geomajas.gwt.client.map.MapModel`). This object stores all map metadata and layers, and has an extensive arsenal of methods to operate on the layers and the features.

Another aspect of the MapModel is the list of events that it fires. Handlers for the following events can be added to the MapModel:

- **MapModelEvent**: this event is fired when the MapModel has been properly initialized. When a MapWidget is added to the HTML page, it automatically triggers an initialization method. This will ask the server to supply it with the correct metadata, so that the MapModel can actually build its layers, etc. Once this initialization process is done, a MapModelEvent will be fired. Add a `org.geomajas.gwt.client.map.event.MapModelHandler` to use this.

- **FeatureSelectedEvent**: this event is fired every time a feature within one of this model's vector layers is selected. Add a `org.geomajas.gwt.client.map.event.FeatureSelectionHandler` to use this.
• FeatureDeselectedEvent: this event is fired every time a feature within one of this model's vector layers is deselected. Add a org.geomajas.gwt.client.map.event.FeatureSelectionHandler to use this.

• LayerSelectedEvent: this event is fired every time a layer within this model is selected. Add a org.geomajas.gwt.client.map.event.LayerSelectionHandler to use this.

• LayerDeselectedEvent: this event is fired every time a layer within this model is deselected. Add a org.geomajas.gwt.client.map.event.LayerSelectionHandler to use this.

2.2. MapView

Part of a map is this org.geomajas.gwt.client.map.MapView object, which determines and influences what area is currently visible. Internally the MapView has a Camera object that you can think of as a satellite that floats above the map. This Camera floats at a certain height, on a certain position, and this will determine what part of the map is shown.

The map contains several coordinate spaces.

• world space: coordinates use the crs of the map.
• screen space: pixel coordinates.
• pan space: objects have already been scaled to the map's current scale, but the translation transformation still needs to occur. This is space is used for rendering the layers and should normally not be used for other purposes.

The MapView provides conversions of coordinates between these spaces. Inside the MapView is a transformer (org.geomajas.gwt.client.spatial.WorldViewTransformer) that is able to transform coordinates, geometries and bounding boxes from screen space to world space and back.

2.3. Workflow

A work flow in the GWT face determines how editing should be handled. It can consist of several steps, called activities. When a work flow finishes, changes will typically be persisted. The package is org.geomajas.gwt.client.map.workflow

Figure 2.1. Workflow API
Activity:

- **execute**: this method is called by the encompassing processor to execute the activity.
- **getErrorHandler**: get the error handler that is specifically tuned for the activity.

WorkflowErrorHandler:

- **handleError**: Executed when an activity throws an exception during execution. The WorkflowProcessor must make sure this method is executed.

WorkflowContext:

- **stopProcess**: informs the WorkflowProcessor to stop the processing of activities. It is the WorkflowProcessors responsibility to ask for this, and execute no more activities when "true" is returned.
- **setSeedData**: provide some seed information to the context. This is usually provided at the time of workflow kickoff.

WorkflowProcessor:

- **supports**: ensure that each activity configured in this process is supported. This method should be called by implemented subclasses for each activity that is part of the process.
- **doActivities**: this method kicks off the processing of workflow activities.
- **setActivities**: set a list of activities to be executed in the process. This would also be a good time to check if activities are supported.
- **setDefaultErrorHandler**: set a default error handler, which is invoked when the activity throws an uncaught exception.

### 2.4. Selection of features

A feature in a vector layer has the possibility to be selected. Selection usually changes the colour of the feature on the map or in a table to make it stand out. The actual selecting handled by the MapModel. In the map model, the selected features are stored. After all, it is possible that by moving away from a certain area, the selected features are no longer in sight, and perhaps no longer in the client layer-cache. Still their contents may be needed for specific tasks.

The MapModel fires events when changes in selection occur. It will fire either FeatureSelectedEvent or FeatureDeselectedEvent. The MapModel implements the HasFeatureSelectionHandler interface so other components can register with the MapModel as FeatureSelectionHandler. For example the MapWidget will register itself as a handler to know when a feature is selected or deselected and redraw it accordingly.
When writing code that needs to react upon the selection of features, implement the FeatureSelectionHandler interface, and register yourself with the MapModel.

**Note**

Individual vector layers can also fire selection events. Actually the MapModel propagates the events from the individual vector layers, so that the user need only install his handlers in one place.

### 3. The spatial package

The spatial package (org.geomajas.gwt.client.spatial) contains a collection of math and geometry related classes and utilities to provide all the client-side calculations one should need. If really complex calculations need to be performed, it's best to let the server (probably using JTS) handle it anyway. The root of the package contains the general mathematical definitions of a Vector, Matrix, LineSegment, and so on. It also provides a general math library and the org.geomajas.gwt.client.spatial.WorldViewTransformer.

The WorldViewTransformer in particular can be a very valuable tool. It allows you to transform coordinates, bounding boxes and geometries between the 3 pre-defined spaces (world, view, pan).

### 3.1. Geometry definitions

All Geometry definitions in the GWT face are based on geometries from JTS, the Java Topology Suite, and the OGC simple feature specification. The classes can be found in the org.geomajas.gwt.client.spatial.geometry package. Supported geometries are:

- **Point**: a geometry representation of a single coordinate.
• MultiPoint: a geometry containing multiple Point geometries.
• LineString: a list of connected coordinates. Sometimes also called a polyline.
• LinearRing: an extension of the LineString geometry that expects the last coordinate to be equal to the first coordinate. In other words, a LinearRing is a closed LineString.
• MultiLineString: a geometry containing multiple LineString geometries.
• Polygon: a Polygon is a two-part geometry, consisting of an exterior LinearRing and a list of interior LinearRings. The exterior LinearRing, also called the shell, is the outer hull of the geometry, while the interior rings can be seen as holes in the exterior ring’s surface area.
• MultiPolygon: a geometry containing multiple Polygon geometries.

3.2. Editing geometries

The Geometry implementations themselves do not have any setters methods. Instead the editing of geometries is done through a series of operations, all implementing the org.geomajas.gwt.client.spatial.geometry.operation.GeometryOperation interface. This interface consists of only one method, accepting a geometry, and returning the result as a new geometry.

Geometries have no public constructors, so the creation of new geometries is done using a factory, org.geomajas.gwt.client.spatial.geometry.GeometryFactory. A GeometryFactory can be created using a spatial reference id and a certain precision, but it can also be retrieved from any geometry instance (where srid and precision are automatically correct).

GeometryOperation interface:

Example 2.1. GeometryOperation interface

```
@Api(allMethods = true)
public interface GeometryOperation {

/**
 * The main edit function. It is passed a geometry object. If other values are needed, pass them through the constructor, or via setters.
 * @param geometry
 * The {@link Geometry} object to be adjusted.
 * @return Returns the resulting geometry, leaving the original unharmed.
 */
Geometry execute(Geometry geometry);
}
```

3.3. Snapping

Snapping in Geomajas, is handled by a single manager class called the org.geomajas.gwt.client.spatial.snapping.Snapper. It is the main handler for snapping to coordinates. It supports different modes of operation and different algorithms for the actual snapping. The different algorithms to use are defined in the vector layer configuration files, while the modes are defined by the different implementations of the SnappingMode class. Let us first start with the different modes:

• ALL_GEOemetries_EQUAL: this snapping mode considers all geometries equal when it comes to determining where to snap to. Depending on the snapping algorithm used, it will consider all nearby geometries.
• **PRIORITY_TO_INTERSECTING_GEOMETRIES**: this snapping mode tries to snap to intersecting geometries before trying the general approach. When searching a snapping coordinate for a given point, this mode will first search for intersecting geometries and try to get a snap to that. If no snapping point can be found, it will consider all nearby geometries (like ALL_GEOMETRIES_EQUAL).

The snapping rules themselves are defined in the server-side configuration. Each vector layer can have many snapping rules. For each rule, 3 fields must be filled:

• **layer**: the target layer to snap to.

• **distance**: the distance over which to snap. This distance must be expressed in the map's coordinate system.

• **type**: the snapping algorithm to use. At the moment 2 types of snapping algorithms are supported: to the nearest point (type=1), and to the nearest edge (type=2). For nearest point snapping can only occur to any coordinate which is a end-point for a geometry, for nearest edge that can be any coordinate on the edge of the geometry. Needless to say, the nearest edge requires more calculating power than the nearest point.

**Snapping on the map**

When a GraphicsController for the map needs to use snapping (i.e. editing controllers), they should extend the org.geomajas.gwt.client.controller.AbstractSnappingController class. This class extends the GraphicsController class (the base class for all Geomajas map controllers), and overwrites the getScreenPosition and getWorldPosition methods to assure the points are snapped. The AbstractSnappingController also supports the on-the-fly activation and deactivation of snapping.

### 4. Graphics & rendering

In the GWT face, the main render method can be found in MapWidget. The render method requires three parameters, a paintable object, a target group to paint in and a status. The paintable object is the actual object that needs to be painted. The target group (org.geomajas.gwt.client.widget.MapWidget.RenderGroup) specifies where in the DOM to draw. The usual choices here are the SCREEN or the WORLD groups. The rendering status (org.geomajas.gwt.client.widget.MapWidget.RenderStatus) determines what drawing action to take.

**RenderStatus**

The render status can be one of the following:

• **ALL**: completely render or re-render the paintable object. If the paintable object contains other paintable object, go through them recursively (a map will paint layers, who in turn will paint tiles,...)

• **UPDATE**: update the paintable object in question, but do not update recursively.

• **DELETE**: delete the paintable object from the map.

While rendering, the map uses a visitor to visit the paintable objects recursively and search for painters for each object or sub-object. The "ALL" status will paint recursively while the "UPDATE" status will not go deeper then the given paintable object. Of course, if a given paintable object has no recursive paintable objects, then the difference between "ALL" and "UPDATE" is irrelevant.

**RenderGroup**

The render group that needs to be specified when calling the map's render method, represents the logical place on the map to draw the paintable object. There are four choices, each having a huge impact.
• **WORLD**: drawing should be done in world coordinates. World coordinates means that the map coordinate system should be used. The advantage of rendering objects in the world group, is that when the user moves the map around, the objects will move with it.

• **SCREEN**: drawing should be done in screen coordinates. Screen coordinates are expressed in pixels, starting from the top left corner of the map. When rendering objects in the screen group they will always appear at a fixed position, even when the user moves the map about.

• **RASTER**: drawing should be done in pan coordinates. All raster layers are drawn in this group. In essence this means that the coordinates are expected to have been scaled for the current scale before drawing, and that only the translation still needs to occur. For advanced use only.

• **VECTOR**: drawing should be done in pan coordinates. All vector layers, their selection and their labels are drawn in this group. In essence this means that the coordinates are expected to have been scaled for the current scale before drawing, and that only the translation still needs to occur. For advanced use only.

### 4.1. GFX interfaces

As will be explained in more detail in the "rendering manual", there are 2 ways of drawing on the map: directly using some rendering context, or indirectly using **Paintable** objects, **Painters** and the **MapWidget**'s **render** method (as explained above). When using the direct approach, one has to call the methods of one of the different rendering contexts. A **MapWidget** contains a **MapContext** implementation, which in turn contains 3 different contexts:

• **MenuContext**: used for keeping details about right mouse clicks. Not used for rendering.

• **ImageContext**: used for rendering images in HTML. All raster layers use this context.

• **GraphicsContext**: the main vector graphics renderer. Can also render images, but uses SVG or VML to do so. When rendering shapes, circles, rectangle, etc. you will always be using this context.
The `GraphicsContext` is the main vector drawing context. It has two implementations: one for SVG and one for VML.
Every object that appears on a Geomajas map, has to implement the **Paintable** interface. This interface marks types of objects that can be painted. For each type/class of paintable object, an accompanying **Painter** must be defined as well. The painter will ultimately decide exactly how a paintable object should be rendered. The painter will render objects using it's `paint` method, or delete objects from the map using it's `deleteShape` method.
• **GraphicsContext**: this is the basic drawing interface. Different implementations will draw in different technologies (i.e. SvgGraphicsContext and VmlGraphicsContext). The whole idea of this GraphicsContext and the painters, was inspired by the Java AWT library. This context will draw basic shapes, according to their id. Since we are using web technologies, all implementations (be they SVG or VML) will use DOM elements to create their drawings.

There are two different kinds of DOM elements we like to distinguish: group elements and non-group elements.

**Group elements** are container elements that have no particular representation of themselves but are used to group other elements and create hierarchical dependency. In SVG, they are represented by `<g>` tags, in VML these are `<group>` tags. **Group elements or groups** can be drawn by passing an arbitrary Java object to the `drawGroup()` method. This object can be used for later reference to the group. To position the group in the hierarchy, a parent group object can be passed as a second parameter to the `drawGroup()` method.

**Non-group elements** (all other elements like circle, rectangle, symbol, etc.) can be drawn by passing a group element - the parent - and a name to the element-specific drawing method (`drawCircle()`, `drawRectangle()`, etc.). These elements will be attached to their parent group in the DOM. Each non-group element in the GraphicsContext DOM tree will therefore have a name and a parent group object. This combination of name and parent can later be used to update or delete the object.

In essence, the drawing methods will result in changes in the visuals of the map, and the painters that will call these methods.

• **Paintable**: the basic definition of an object that can be painted onto the map. For each Paintable class, an accompanying Painter class must be defined. The Paintable interface has only two methods. The `getId` method returns the Paintable objects id, which is it's key in the DOM tree.
within the parent group. While the accept method will be traversed by the PainterVisitor, and is used to have the object passed to the correct Painter, which will draw the object.

- **WorldPaintable**: extension of the Paintable interface for objects that support being rendered in world space. This means that it should be possible to transform the object's geometry/location/coordinate/bbox.

- **Painter**: A Painter knows how to paint a specific kind of Paintable object. Exactly what class of Paintable objects it can draw, must be made clear by its getPaintableClassName method. Furthermore, the Painter has two methods to paint or remove Paintable objects on or from the given GraphicsContext. Basically, the Painter translates the fields and parameters of the Paintable object into calls to the GraphicsContext.

- **PainterVisitor**: Geomajas uses a visitor algorithm for its client side rendering process. The MapWidget uses a PainterVisitor to recursively traverse the tree of Paintable objects, calling the accept method on each node.

  Of course this recursive system of searching for the correct Painter, can only work when the PainterVisitor has all the necessary painters registered. When registering a Painter with the MapWidget, it will actually pass it along to this PainterVisitor instance.

  An example of the recursive painting, can be found in the MapModel, which calls the accept methods of its layers, which call the accept methods of the visible tiles, which contain features.

### 4.2. Rendering manual

There are two ways to render objects onto the map. One uses Paintable objects and Painters, the other is by using the GraphicsContext directly. There are still some general notions that one must know before attempting to draw on the map. Since HTML, SVG and VML are all markup languages which use a DOM tree as basic model, rendering basically is the adding and removing of nodes within this tree. As parent nodes have styling information or other attributes that reflect their child nodes, it is very important to add nodes to the correct parent when drawing.

The GraphicsContext reflects this, by requiring a parent object as first parameters in all drawing methods. Associated with every node is an object that represents it. Given this object, the GraphicsContext can find the correct node. When using the GraphicsContext directly, it is important to be aware of the necessity of using the correct parent group when drawing.

#### 4.2.1. The simple approach - indirect drawing

##### 4.2.1.1. Drawing in screen space

This approach uses MapWidget's render method, which requires three parameters: a Paintable object, a target RenderGroup, and a RenderStatus. If you are unfamiliar with these, visit the beginning of this chapter for a detailed description.

Let us start with an example, where we draw a rectangle in screen space (=pixel coordinates). The code would look something like this:

```java
Rectangle rectangle = new Rectangle("myRectangle");
rectangle.setBounds(new Bbox(10, 10, 200, 200));
rectangle.setStyle(new ShapeStyle("#FF0000", .8f, ".000FF", .6f, 2));
map.render(rectangle, RenderGroup.SCREEN, RenderStatus.ALL);
```

This code snippet would draw a rectangle (which implements Paintable), called "myRectangle" in screen space (10 pixels from the top, 10 pixels from the left, and with a width and height of both 200), using the defined style (red interior with a blue border). To delete the rectangle again, you would have to do something like this:
map.render(rectangle, RenderGroup.SCREEN, RenderStatus.DELETE);

### 4.2.1.2. Drawing in world space

Remember that there was also an extension of the Paintable interface, designed for rendering objects in world space. Rendering in world space means that objects are drawn in the coordinate system of the map. This also means that when the user moves about on the map, the object will move with it (keeping the same location in map coordinates). Only objects that implement the WorldPaintable interface can be drawn in world space.

Let us, for the next example, assume that the map has been defined using EPSG:4326 (lonlat) as coordinate system, and we would apply the following code snippet:

```java
Rectangle rectangle = new Rectangle("myRectangle");
rectangle.setBounds(new Bbox(-60, -60, 120, 120));
rectangle.setStyle(new ShapeStyle("#FF0000", .8f, "#0000FF", .6f, 2));

// Register the rectangle to the map, so that it gets redrawn
// automatically when the user navigates on the map.
map.registerWorldPaintable(rectangle);
```

Starting from -60, -60 and using a width and height of 120, we would have a rectangle that encompasses a huge part of the world. Note that drawing objects in world space requires you to register them with the map. This is necessary to have the map automatically update the object's position when the user navigates. When registering the WorldPaintable rectangle, it is automatically drawn on the map.

### 4.2.2. The advanced approach - using the GraphicsContext directly

When more flexibility is required from the rendering system, the map's render method might sometimes not be enough. If for example we want to render more than one object within a specific parent group. The following code snippet shows how to render a specific parent in screen space and then render a circle within this parent group:

```java
// Create a parent group within screen space:
Composite parent = new Composite("myParent");
map.getVectorContext().drawGroup(map.getGroup(RenderGroup.SCREEN), parent);

// Draw a circle at (20, 20) with radius 10 pixels within parent group:
Coordinate pos = new Coordinate(20, 20);
ShapeStyle style = new ShapeStyle("#FF0000", .8f, "#0000FF", .6f, 2);
map.getVectorContext().drawCircle(parent, "myCircle", pos, 10, style);
```

Since no special parameters are added to the "myParent" node, the circle is drawn as if it were in the screen group itself. But thanks to the extra parent group, we now have the ability for apply specific styling or transformations on that parent group, and thus altering all children within it. Let us for example move the circle 100 pixels to the right:

```java
// Translate the parent group 100 pixels to the right:
Matrix m = new Matrix(1, 0, 0, 1, 100, 0);
map.getVectorContext().drawGroup(map.getGroup(RenderGroup.SCREEN), parent, m);
```

**Warning**

Do not try to render objects in world space by directly accessing the GraphicsContext. Behind the screens of the MapWidget, the world space objects are actually transformed and rendered in vector space. This is done to avoid scaling in the DOM tree (as this is not possible cross browsers).
5. User interaction

This section covers the many interfaces regarding buttons, menu items and such that make up the user interface. The specific Geomajas widgets (i.e. LayerTree) require a specific way of doing things. We will cover the interfaces for the Toolbar, LayerTree, map controllers and context menus.

- **Toolbar**: the tool bar has two types of default actions one can add to it (there is always the addChild method, which can add any widget, but we are now talking about Geomajas specific possibilities): the ToolbarAction and the ToolbarModalAction. The ToolbarAction is used for actions that need immediate response upon clicking, while the ToolbarModalAction is used for enabling or disabling a certain state.

- **LayerTree**: the LayerTree has the possibility to add buttons to it's tool bar that usually act upon the selected layer within the LayerTree. Again two types of actions can be added: the LayerTreeAction and the LayerTreeModalAction. The same difference as with the tool bar applies: the LayerTreeAction is a base abstract class for actions that execute immediately upon clicking, while the LayerTreeModalAction is used for enabling or disabling a certain state (for example: toggle the layer's visibility).

- **Menu**: each item in a context menu should extend the MenuAction base class. This is your basic starting point for easily creating new menu items or context menu items.

- **Controllers on the map**: for controllers listening to mouse events on a map, there is the GraphicsController interface, or an abstraction under the name of AbstractGraphicsController.

**Note**

For buttons in the Toolbar or LayerTree it is possible to add them to the org.geomajas.gwt.client.action.toolbar.ToolbarRegistry or org.geomajas.gwt.client.action.layertree.LayerTreeRegistry upon application startup (before MapWidget initialisation!). This allows you to add new buttons which can be included in the map configuration.

5.1. Toolbar: ToolbarAction

The ToolbarAction is your basic abstract class for building tool bar buttons that are executed immediately when clicked. The class implements the ClickHandler interface and requires your to specify an icon and a tool tip on creation.

ToolbarAction classes need to be registered in the ToolbarRegistry class. This allows you to get an instance of the widget to put in the tool bar. The tools which are part of the GWT face are statically defined in the class. Other tools can be added (or overwritten) at runtime before the map is initialised.

When a ToolbarAction is configurable (XML configuration), it should implement the ConfigurableAction interface. This contains a "configure()" method which will be called for each of the parameters which are defined in the tool configuration.

**Example 2.2. ToolbarAction**

```java
/**
 * Abstract class that serves as a template for building tool bar actions. A tool bar action is an action that
 * executed immediately when the tool bar button is clicked. If you want a selectable tool bar button, have a look
 * the [link ToolbarModalAction] class.
 */
```
public abstract class ToolbarAction extends ToolbarBaseAction implements ClickHandler {
    /**
     * Constructor.
     *
     * @param icon icon
     * @param tooltip tooltip
     */
    public ToolbarAction(String icon, String tooltip) {
        this(icon, tooltip, tooltip);
    }

    /**
     * Create a new ToolbarAction.
     *
     * @param icon icon
     * @param title title
     * @param tooltip tooltip
     * @since 1.10.0
     */
    public ToolbarAction(String icon, String title, String tooltip) {
        super(icon, title, tooltip);
    }
}

5.2. Toolbar: ToolbarModalAction

The ToolbarModalAction is the basic template for creating selectable tool bar buttons. Usually they enable and disable a certain state on the map when selected or deselected. Many of the implementations that come with Geomajas set a new controller on the map when they are selected.

Note that only one of these ToolbarModalActions can be selected at any given time. In that sense they act as radio buttons.

ToolbarModalAction classes need to be registered in the ToolbarRegistry class. This allows you to get an instance of the widget to put in the tool bar. The tools which are always part of the GWT face are statically defined in the class. Other tools can be added (or overwritten) at runtime before the map is initialised.

When a ToolbarAction is configurable, it should implement the ConfigurableAction interface. This contains a configure() method which will be called for each of the parameters which are defined in the tool configuration.

Example 2.3. ToolbarModalAction

/**
 * Abstract class which serves as a template for selectable buttons in a tool bar.
 * selected and deselected. With each of these actions a different method is executed
 * button is used to set a new controller onto the (link org.geomajas.gwt.client).
 * for an action that should be executed immediately when clicking on it, have a
 * (link org.geomajas.gwt.client.action.ToolbarAction) class.
 * *
 * @author Pieter De Graef
 * @since 1.6.0
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5.3. LayerTree: LayerTreeAction

The LayerTreeAction is your basic abstract class for building layer tree buttons that are executed immediately when clicked. The onClick() method needs to be implemented and it also requires you to specify an icon, a tool tip and a disabled icon. Note that the onClick() has the selected layer within the LayerTree as a parameter.

LayerTreeAction classes need to be registered in the LayerTreeRegistry class. The tools which are always part of the GWT face are statically defined in the class. Other tools can be added (or overwritten) at runtime before the map is initialised.

Example 2.4. LayerTreeAction

```java
public abstract class LayerTreeAction extends ToolbarBaseAction {

    /*
     * Constructor.
     * 
     * @param icon icon
     * @param tooltip tooltip
     */
    public LayerTreeAction(String icon, String tooltip) {
        super(icon, tooltip, tooltip);
    }

    /**
     * Create a new LayerTreeAction.
     * 
     * @param icon icon
     * @param title title
     * @param tooltip tooltip
     * @since 1.10.0
     */
    public LayerTreeAction(String icon, String title, String tooltip) {
        super(icon, title, tooltip);
    }

    // Class specific actions:

    /**
     * When the tool bar button is selected, this method will be called.
     * 
     * @param event event
     */
    public abstract void onSelect(ClickEvent event);

    /**
     * When the tool bar button is deselected, this method will be called.
     * 
     * @param event event
     */
    public abstract void onDeselect(ClickEvent event);
}
```
private String disabledIcon;

/**
 * Constructor setting all values.
 * @param icon The default icon for the button.
 * @param tooltip The default tooltip for the button.
 * @param disabledIcon The icon used when the button is disabled.
 */
public LayerTreeAction(String icon, String tooltip, String disabledIcon) {
    super(icon, tooltip);
    this.disabledIcon = disabledIcon;
}

/**
 * This method will be called when the user clicks on the button.
 * @param layer The currently selected layer.
 */
public abstract void onClick(Layer<?> layer);

/**
 * Is the this action enabled for the layer?
 * @param layer layer to test
 * @return enabled status of action for layer
 */
public abstract boolean isEnabled(Layer<?> layer);

/**
 * Set icon to display when button is disabled.
 * @return icon shown when the button is disabled
 */
public String getDisabledIcon() {
    return disabledIcon;
}

/**
 * Set icon for disabled state.
 * @param disabledIcon icon for disabled state
 */
public void setDisabledIcon(String disabledIcon) {
    this.disabledIcon = disabledIcon;
}

5.4. LayerTree: LayerTreeModalAction

The LayerTreeModalAction is the basic template for creating selectable layer tree buttons. Usually they enable and disable a certain state for the selected layer within the layer tree (for example that layer's visibility).

LayerTreeModalAction classes need to be registered in the LayerTreeRegistry class. The tools which are always part of the GWT face are statically defined in the class. Other tools can be added (or overwritten) at runtime before the map is initialised.
5.5. Menu: MenuAction

To create menu items or context menu items, Geomajas provides a base which extends from SmartGWT's MenuItem class. It requires you to set a title and icon. It also implements the ClickHandler interface for defining the onClick() execution function.

Example 2.5. MenuAction

```java
/**
 * General definition of a <code>MenuAction</code>. All Geomajas actions in toolbars or context menus should build upon this class.
 *
 * @author Pieter De Graef
 * @since 1.6.0
 */
@Api(allMethods = true)
public abstract class MenuAction extends MenuItem implements ClickHandler {

    /**
     * Constructor that expects you to immediately fill in the title and the icon.
     *
     * @param title The textual title of the menu item.
     * @param icon A picture to be used as icon for the menu item.
     */
    protected MenuAction(String title, String icon) {
        super(title, icon);
        addClickHandler(this);
    }
}
```

5.6. Controllers on the map

5.6.1. GraphicsController

For interactive mouse controllers on the map there is a general interface, GraphicsController. To write a custom controller, you should always extend AbstractGraphicsController.

Caution

The GraphicsController interface does NOT use SmartGWT events as they provide no way of getting the target DOM element from the mouse events. So the list of handlers that the GraphicsController extends, are all basic GWT event handlers. A separate widget (GraphicsWidget) has been created to catch the events, while the normal MapWidget (which encapsulates the GraphicsWidget) can still handle SmartGWT events.

On top of all the event handling methods that come from the different handlers, the interface also has onActivate() and an onDeactivate() methods. The onActivate() is called before the controller is actually applied on the GraphicsWidget. This is usually used to apply a new context menu on the map and such. The onDeactivate() method is called when the controller is removed from the GraphicsWidget. This is usually used for cleaning up.

Example 2.6. GraphicsController

```java
/**
 * <p>
 * General interface for a controller set on a {link org.geomajas.gwt.client.widget.MapWidget
```
These controllers can do anything they want with these mouse events, and as a result only one controller can be active on a map at any given time. This is also the difference between controllers and listeners. A Listener passively listens to mouse events without ever interfering, so a maximum of listeners that can be active on a map at any given time.

`<p>`

@since 1.6.0

`</p>`

@author Pieter De Graef

@since 1.6.0

```java
@Api(allMethods = true)
public interface GraphicsController extends /*MouseDownHandler, MouseUpHandler, MouseOverHandler, MouseWheelHandler, DoubleClickHandler*/ Controller {

/**
 * Function executed when the controller instance is applied on the map.
 */
void onActivate();

/**
 * Function executed when the controller instance is removed from the map.
 */
void onDeactivate();

/**
 * An offset along the X-axis expressed in pixels for event coordinates. Used when controllers are placed on specific elements that have such an offset as compared to the origin of the map. X,Y coordinates relative from their own position, but need this extra offset so that we can still calculate the correct screen and world position.
 *
 * @since 1.8.0
 * @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354. No longer used.
 */
@Deprecated
int getOffsetX();

/**
 * An offset along the X-axis expressed in pixels for event coordinates. Used when controllers are placed on specific elements that have such an offset as compared to the origin of the map. X,Y coordinates relative from their own position, but need this extra offset so that we can still calculate the correct screen and world position.
 *
 * @param offsetX
 * Set the actual offset value in pixels.
 *
 * @since 1.8.0
 * @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354. No longer used.
 */
@Deprecated
void setOffsetX(int offsetX);

/**
 * An offset along the Y-axis expressed in pixels for event coordinates. Used when controllers are placed on specific elements that have such an offset as compared to the origin of the map. X,Y coordinates relative from their own position, but need this extra offset so that we can still calculate the correct screen and world position.
 */
```
You should never directly implement GraphicsController (not that it does not have the "@UserImplemented" annotation), you should always extend AbstractGraphicsController. This abstract class implements all methods as empty methods so you don’t have to clutter your code with empty methods (often only a few of the mouse event methods are actually used). It also has some extra methods for return useful information for the mouse events, such as the position (expressed in screen coordinates) or the target DOM element.

Small extract from the AbstractGraphicsController class:

**Example 2.7. Extract from AbstractGraphicsController**

```java
/**
 * Use the <code>getLocation</code> method instead.
 * 
 * @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354.
 */
@Deprecated
protected Coordinate getScreenPosition(MouseEvent<?> event) {
    return getLocation(event, RenderSpace.SCREEN);
}

protected Coordinate getClientPosition(MouseEvent<?> event) {
    return new Coordinate(event.getClientX(), event.getClientY());
}

protected Coordinate getPanPosition(MouseEvent<?> event) {
    Element element = mapWidget.getDOM();
    double offsetX = ((MouseEvent<?>) event).getRelativeX(element);
    double offsetY = ((MouseEvent<?>) event).getRelativeY(element);
    return getTransformer().viewToPan(new Coordinate(offsetX, offsetY));
}

/**
 * Use the <code>getLocation</code> method instead.
 * 
 * @since 1.8.0
 * @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354.
 */
@Deprecated
int getOffsetY();
```

```java
/**
 * An offset along the Y-axis expressed in pixels for event coordinates. Used on specific elements that have such an offset as compared to the origin of the X,Y coordinates relative from their own position, but need this extra offset to still calculate the correct screen and world position.
 * 
 * @param offsetY
 * @param Set the actual offset value in pixels.
 * @since 1.8.0
 * @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354.
 */
@Deprecated
void setOffsetY(int offsetY);
```
* @deprecated Since 1.10, due to http://jira.geomajas.org/browse/GWT-354. */
@Deprecated
protected Coordinate getWorldPosition(MouseEvent<?> event) {
    return getLocation(event, RenderSpace.WORLD);
}

protected Element getTarget(MouseEvent<?> event) {
    return GwtEventUtil.getTarget(event);
}

protected String getTargetId(MouseEvent<?> event) {
    return GwtEventUtil.getTargetId(event);
}

Now that you have your controller you can set it;

mapWidget.setController(new MeasureDistanceController(mapWidget));

Note

There are more abstractions than just the AbstractGraphicsController:

• AbstractRectangleController : abstract controller that handles drawing a rectangle by dragging the mouse on the map.

• AbstractSnappingController : abstract controller that allows snapping to be enabled and disabled. When enabled, the returned points when asking getPosition(), are snapped (depending on the configured snapping rules).

In order to disable the active controller, set a "null" value as controller:

mapWidget.setController(null);

5.6.2. Active and fallback controllers

Only one GraphicsController can be active at any one time on a map. This is done deliberately in order for controllers not to interfere with each other. By default the MapWidget uses a "fallback controller" that is activated when no explicit controller is set (a navigation controller by default). So when no explicit controller is set, or mapWidget.setController(null) is used, the map will turn to it's fallback controller.

It is possible to replace this fallback controller by another than the default, by calling:

mapWidget.setFallbackController(<the new controller>);

In order to completely disable the use of a fallback controller, set "null" as the new fallback controller.

5.7. Addons on the map

A way to let a user set controllers on the map is by providing addons for him/her on the map. Default addons are provided to pan and zoom in and out:

Code-wise an addon is basically an (SmartGWT) widget composed out of background image, a foreground image (or icon) and a GraphicsController.
Figure 2.6. Default map addons

Beside these default addons you can create your own addons by combining a background image, with an icon and a GraphicsController or a ToolbarAction.

Before you can add your own addons however, your first need to disable the creation of the default addons by setting the property "panButtonsEnabled" of your ClientMapInfo bean to false.

```xml
<bean name="mapNoNav" class="org.geomajas.configuration.client.ClientMapInfo">
    <property name="panButtonsEnabled" value="false" />
</bean>
```

**Note**

The name of the ClientMapInfo bean is the id used in the constructor of the MapWidget.

Now you can create an addon by constructing a SingleMapAddon. Depending on your desires you can construct a SingleMapAddon in different ways:

- With just a icon or with a background image as well.
- With a GraphicsController or a ToolbarAction.
- With a explicit size or automatically based on the size of the given image(s).

The creation of a zoom-in SingleMapAddon can be achieved like this:

**Example 2.8. Create a SingleMapAddon**

```java
// Default background for following add ons.
Image background = ImageUtil.createSquareImage("background",
    Geomajas.getIsomorphicDir() + "geomajas/mapaddon/panbg.png", 0,
    0, BUTTON_DIA);

// Zoom in
Image in = ImageUtil.createSquareImage(ZOOM_IN + ICON,
    Geomajas.getIsomorphicDir() + "geomajas/osgeo/zoom-in.png",
    MARGIN, MARGIN, ICON_DIA);
SingleMapAddon zoomIn = new SingleMapAddon(ZOOM_IN, in, background,
    mapWidget, new ZoomInAndOutController(mapWidget, 2));
```

A more complex zoom slider is created like this:

**Example 2.9. ZoomSlider map add-on**

```java
// Slider handler icon
Image sliderUnit = ImageUtil.createRectangleImage(
```
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ZoomSlider.SLIDER_UNIT + "icon", Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderUnit.png", 0, 0, SLIDER_UNIT_WIDTH, SLIDER_UNIT_HEIGHT);

// Part of the background on which the zoom slider handler can move. One zoom level is represented by one image.
Image backgroundPart = ImageUtil.createRectangleImage(ZoomSlider.SLIDER + "Bg",
Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderbg.png", 0, 0, SLIDER_WIDTH, SLIDER_PART_HEIGHT);

// Zoom in; the top of ZoomSlider
Image in = ImageUtil.createSquareImage(ZOOM_IN + ICON,
Geomajas.getIsomorphicDir() + "geomajas/mapaddon/zoomPlus.png",
0, 0, SLIDER_WIDTH);
Image sliderTop = ImageUtil.createSquareImage(ZoomSlider.SLIDER + "Top",
Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderbgtop.png", 0, 0, SLIDER_WIDTH);
SingleMapAddon zoomIn = new SingleMapAddon(ZOOM_IN, in, sliderTop, mapWidget, new ZoomInAndOutController(mapWidget, 1.01));

// Zoom out; the bottom of ZoomSlider
Image out = ImageUtil.createRectangleImage(ZOOM_OUT + ICON,
Geomajas.getIsomorphicDir() + "geomajas/mapaddon/zoomMinus.png",
0, 0, SLIDER_WIDTH, SLIDER_PART_HEIGHT);
Image sliderBottom = ImageUtil.createRectangleImage(ZoomSlider.SLIDER + "Bottom",
Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderbgbottom.png", 0, 0, SLIDER_WIDTH, SLIDER_PART_HEIGHT);
SingleMapAddon zoomOut = new SingleMapAddon(ZOOM_OUT, out, sliderBottom, mapWidget, new ZoomInAndOutController(mapWidget, 0.99));

// Zoom slider itself
ZoomSlider slider = new ZoomSlider(ZoomSlider.SLIDER, mapWidget);
slider.setZoomIn(zoomIn);
slider.setZoomOut(zoomOut);
slider.setHorizontalMargin(HORIZONTAL_MIDDLE - SLIDER_WIDTH / 2);
slider.setVerticalMargin(pan.getVerticalMargin() + PAN_DIA + 2 * MARGIN);
mapWidget.registerMapAddon(slider);
mapWidget.getMapModel().getMapView().addMapViewChangedHandler(slider);

/*
* Slider handler icon
*/
Image sliderUnit = ImageUtil.createRectangleImage(ZoomSlider.SLIDER_UNIT + "icon",
Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderUnit.png", 0, 0, SLIDER_UNIT_WIDTH, SLIDER_UNIT_HEIGHT);

/*
* Part of the background on which the zoomslider handler can move.
*/
Image backgroundPart = ImageUtil.createRectangleImage(ZoomSlider.SLIDER + "Bg",
Geomajas.getIsomorphicDir() + EXAMPLE_IMAGE_FOLDER + "sliderbg.png", 0, 0, SLIDER_WIDTH, SLIDER_PART_HEIGHT);

/*
* Zoom in; the top of ZoomSlider
*/
Image in = ImageUtil.createSquareImage(ZOOM_IN + ICON,
Geomajas.getIsomorphicDir() + "geomajas/mapaddon/zoomPlus.png",
0, 0, SLIDER_WIDTH);
Note

For the full snippet in the Geomajas showcase, open the Map and rendering section, click the Zoom slider example and view the attached sources.

5.8. Listeners on the map

As an alternative to the interactive controllers on a map, there are passive Listeners as well. These listener have an interface very much like the GraphicsController interface, but they never receive the real mouse events. As such they are meant to be passive observers, which receive notifications of mouse events. As opposed to the GraphicsControllers, these listeners are never allowed to interfere.

As a result, multiple listeners can be registered on the map, while only one GraphicsController can be active at any given time. Instead of the real mouse events, listeners receive placeholder events of the type ListenerEvent. These ListenerEvent objects resemble the GWT mouse events a bit, and contain most of the information of the real mouse events.

In order to add a listener to the map, or remove a listener from the map, your code should be something like this:

```java
// Define a new Listener, starting from the AbstractListener:
Listener myListener = new AbstractListener() {
```
```java
public void onMouseMove(ListenerEvent event) {
    // Do something...
}
}

// Add the Listener to the map:
mapWidget.addListener(myListener);

// Remove the Listener from the map:
mapWidget.removeListener(myListener);

Note
When creating a new Listener, often it is easiest to start from the AbstractListener class, which has all empty methods for catching the mouse events. In this case you override the methods for the events you are interested in.

5.9. Changing the cursor on the map

The MapWidget in the GWT face provides the possibility to apply different cursors when hovering the map. In previous versions this was done through the setCursor method, which only supported default cursors. Since version 1.10 of the GWT face however, the MapWidget also provides the setCursorString method, which support custom images to be used as cursors on top of the default cursors.

6. Internationalization in Geomajas

For internationalization, Geomajas uses the default GWT i18n implementation. For Geomajas specifically, the i18n is used in several places, each having it's own list of messages. Basically all i18n message definitions are located in the package org.geomajas.gwt.client.i18n, as are the properties files containing the translations.

Several separate definitions have been created:

- **MenuMessages**: the MenuMessages defines parameterized string values that are used in the titles of MenuAction classes. Examples are the editing context menus.
- **ToolbarConstants**: this defines strings that are used as tool tips when hovering over the buttons in the tool bar. This list of values is used by the ToolbarAction and ToolbarSelectAction classes. Note that for tool tips the "&nbsp;" character is used instead of the default space.
- **AttributeMessages**: ..... 
- **GlobalMessages**: ..... 
- **LayerTreeMessages**: ..... 
- **SearchMessages**: ..... 

To avoid multiple instantiations of the constants and messages classes and have a central access point for all internationalization concerns, the I18nProvider class has been created. This class has static methods for accessing the constants and messages classes. Usage is as follows:

```java
String dist = I18nProvider.getMenu().getMeasureDistanceString(totalDistance, radius);
setContents( "<div><b>" + I18nProvider.getMenu().distance() + "</b>:" + dist + "</div>" );
```

7. Styling and skinning

The GWT face uses SmartGWT for the widgets, styling and skinning. The skin for the application is defined in your.gwt.xml file. This can for example be done using something like:
Extra tuning can be done in CSS.

In some cases this is not sufficient. SmartGWT handles the flowing of widgets itself based on CSS and size and position information which is included in code. To alleviate this, there is a special class names WidgetLayout which contains many of the fixed values which are used for the sizing and styling used in the widgets. The fields in the class can be set on the onLoad() method in your GWT entry point class to influence the style of the widgets.

8. Unit testing GWT widgets

A GWT unit test should inherit from the GWTTestCase base class and should be named GwtTestXxx.java. GWT unit tests are run inside a development mode environment and can refer to most of the GWT API. To run a GWT test case, run the Maven command gwt:test or execute the integration test phase.

9. Creating (custom) feature forms

This functionality has been added to the GWT client API in version 1.9.0.

When working with vector layers, one often has a need for editing not only the vector component of the features, but also the alpha-numerical attributes. To this end, special factories have been created that can be passed to the editing widgets (FeatureAttributeEditor and FeatureAttributeWindow) to create such forms.

All interfaces and classes in this section can be found in the following package: org.geomajas.gwt.client.widget.attribute

Central in all this, is the FeatureForm and the FeatureFormFactory. The FeatureFormFactory is an interface that defines a single method for the creation of a FeatureForm instance.

Example 2.10. FeatureFormFactory interface

```java
public interface FeatureFormFactory {

/**
 * Creates a form using the specified attribute information.
 * @param infos List of attribute definitions. Normally taken from a VectorLayer.
 * @return An attribute form that allows for editing of it's values.
 */
    FeatureForm createFeatureForm(VectorLayer layer);
}
```

The default implementation of this factory has been implemented as DefaultFeatureFormFactory. This factory returns a default implementation for the feature form for each layer: DefaultFeatureForm. When the default layout of a feature form is sufficient use the DefaultFeatureFormFactory as is, otherwise feel free to implement your own factory that returns custom instances of a FeatureForm.

The FeatureForm is a form definition that has been tuned towards the Geomajas GWT feature definition, and is used in the central editing widgets (FeatureAttributeEditor and FeatureAttributeWindow). Note that those editing widgets have constructors to accept a FeatureFormFactory, so you have to pass them a custom factory that returns your custom form.
Of course implementing your own FeatureForm might be a bit overwhelming and fortunately is usually not necessary as you can easily extend the DefaultFeatureForm to suit your needs. The DefaultFeatureForm has several hooks to allow you to influence its layout:

- The `createField(AttributeInfo)` and/or `createItem(AttributeInfo)` methods can be overridden to customize form items or create your own.
- The `isIncluded(AttributeInfo)` method can be overridden to omit certain attributes.
- The `prepareForm(FormItemList, DataSource)` method can be overridden to set the layout properties of the form and add additional items such as spacers or headers.

Adding new form item types can also be done in a more global way. Therefore, an extra utility class has been added to create the individual form items that represent the feature's attributes. This utility class is the `AttributeFormFieldRegistry`. This registry keeps a pre-defined set of form item definitions and data source fields (both are necessary to successfully create forms in SmartGWT) that map onto attribute types. For example, it will map a DateItem and DataSourceDateField onto all attributes of type "DATE". This registry can now be used to create the individual items within the form, or to register custom form items types to use in the forms.

Note

Internally, the `org.geomajas.gwt.client.widget.attribute.DefaultFeatureForm` makes use of the `AttributeFormFieldRegistry`. This means that if you register custom form items for certain attribute types, these custom items will also appear in the default feature forms, without you having to implement a custom FeatureForm.

In the following sections, the details of registering custom form items and creating custom forms will be explained.

9.1. Using custom form items within a FeatureForm

In order to use custom form items within a FeatureForm, there are 2 ways: override one the default for a certain attribute type, or define a completely new type.

In any case, you will need to register a custom type with the `AttributeFormFieldRegistry`. Let us start with a coding example:

```java
// We define the custom type "myType" in the AttributeFormItemFactory:
AttributeFormFieldRegistry.registerCustomFormItem("myType", new DataSourceFieldFactory() {
    public DataSourceField create() {
        return new DataSourceIntegerField();
    }
}, new FormItemFactory() {
    public FormItem create() {
        return new SliderItem();
    }
}, null);
```

This short piece of code will register a "SliderItem" for all attributes of the type "myType". Let us first go over the code in more detail. In order to register a new type, 4 arguments are required:

- The key associated with the given `FormItemFactory` and `DataSourceFieldFactory`. This key is either the name of an attribute type (i.e. `PrimitiveType.DATE.name()`) to overwrite the default definitions, or a completely new type which can be configured in the attribute
definitions with the `formInputType` field (see further in this section). This key is a unique identifier. In the example above: "myType".

- A `DataSourceFieldFactory` definition. This factory will create a SmartGWT `DataSourceField` that represents the underlying data-source in the form.

- A `FormItemFactory` definition. This factory will create a SmartGWT `FormItem` that represents the actual widget by which the attribute is presented in the form. In the case above, the attribute will be represented by a `SliderItem`.

- A list of validators that can be attached to the underlying `DataSourceField`. Any time the user changes values within a `FeatureForm`, the associated validators will be executed. In the example above no extra validators are attached to the `DataSourceIntegerField` (value null).

So the parameter explanation already told us how to overwrite the default attribute types: by registering a new type for an attribute type (i.e. `PrimitiveType.DATE.name()`). The other option, to register completely new types, is done by using a new key (i.e."myType"). The only thing left to do than is to associate attributes with this key. This can be done within the vector layer XML configuration, where a field by the name of "formInputType" can be added to an attribute configuration. For more information on attribute configuration, visit the configuration part in the Geomajas developer guide [http://files.geomajas.org/maven/trunk/geomajas/docbook-devuserguide/html/master.html#conf-vectorInfo].

### 9.2. Using custom form items for association attributes

Association attributes (one-to-many and many-to-one) require a specific treatment because they are too complex to be mapped to a single-valued form item. For these attributes, special interfaces have been constructed that provide full control over the way association value data travels between the feature and it's form representation:

- The `ManyToOneItem` interface defines the contract for a custom form item that represents a many-to-one association

- The `OneToManyItem` interface defines the contract for a custom form item that represents a one-to-many association

Both interfaces contain the following methods:

- `getItem()`: this method returns the actual form item to be used in the form. This can either be an item that holds the actual value or a button or link that opens a more complex editor.

- `fromItem(), toItem()`: these methods govern the actual transfer of data between the form and the association value. This may include transfer from and to a more complex editor.

- `init(AssociationAttributeInfo attributeInfo, AttributeProvider attributeProvider)`: this method provides a way to initialize the custom form item and/or editor. It passes information on the nested attributes of the association value and an attribute provider interface. The provider interface allows to query a list of possible attribute values in case the user has to select the value from a predefined list.

- `clearValue()`: this method allows custom clearance of the form item and editor.

The default implementation of `ManyToOneItem` is a simple combobox.

The default implementation of `OneToManyItem` is a "More..." link that pops up a master-detail editor configuration for editing a list of association values.

These are in line with our default interpretation of a many-to-one attribute as being an association by reference to an externally managed list and a one-to-many item as being a parent-child relationship.
Custom behavior can of course be implemented by registering a different implementation of the interfaces.

9.3. Creating a custom FeatureForm

The next step is to create a custom FeatureForm. Let us again start with a short code example:

```java
public class AttributeCustomForm extends DefaultFeatureForm {

    public AttributeCustomForm(VectorLayer vectorLayer) {
        super(vectorLayer);
    }

    @Override
    protected FormItem createItem(AttributeInfo info) {
        FormItem formItem = super.createItem(info); // call super to create the default item
        formItem.setWidth("*");
        if ("dateAttr".equals(info.getName())) {
            // The date attribute will span all 4 columns:
            formItem.setColSpan(4);
        }
        return formItem;
    }

    @Override
    protected void prepareForm(FormItemList formItems, DataSource source) {
        // Quickly insert a row spacer before the 'stringAttr' item (which is the text area).
        formItems.insertBefore("stringAttr", new RowSpacerItem()); // inserting an item via the FormItemList
        getWidget().setNumCols(4);
        getWidget().setWidth(450);
        getWidget().setColWidths(100, 180, 20, 150);
        getWidget().setGroupTitle("Custom Attribute Form");
        getWidget().setIsGroup(true);
    }
}
```

The `createItem(AttributeInfo info)` method is overridden to set the item width and make the date attribute span 4 columns. The `prepareForm(FormItemList formItems, DataSource source)` method is overridden to insert an extra spacer item before the string attribute and set the general column layout. The form that results from this will not differ all too much from the default implementation, but it should get you on your way.
Chapter 3. Configuration

To use the GWT face, you have to include the relevant dependencies, the required build steps, and make sure the GWT dispatcher servlet is included in your web.xml.

1. Dependencies

You have to include the GWT face (client) module. As this is a GWT specific jar, it already includes the source (in many other cases, you would need to explicitly add the sources as well).

Example 3.1. Include GWT client dependency

```xml
<dependency>
  <groupId>org.geomajas</groupId>
  <artifactId>geomajas-gwt-client</artifactId>
</dependency>
```

You also include the GWT dependencies themselves. Even though these dependencies are already used by the geomajas-gwt-client module, they need to be redefined because of the scopes.

Example 3.2. GWT dependencies

```xml
<dependency>
  <groupId>com.google.gwt</groupId>
  <artifactId>gwt-user</artifactId>
  <scope>provided</scope>
</dependency>
<dependency>
  <groupId>com.google.gwt</groupId>
  <artifactId>gwt-servlet</artifactId>
  <scope>runtime</scope>
</dependency>
```

These snippets don’t include any version info. It is assumed that you use the geomajas-project-client-gwt module in a recent incarnation to assure these versions are set.

Example 3.3. Including geomajas-project-client-gwt for module versions

```xml
<dependencyManagement>
  <dependency>
    <groupId>org.geomajas.project</groupId>
    <artifactId>geomajas-project-client-gwt</artifactId>
    <version>1.15.1</version>
    <type>pom</type>
    <scope>import</scope>
  </dependency>
</dependencyManagement>
```

If you want to use a snapshot version of the GWT client, you should change the version of the geomajas-project-client-gwt dependency to the desired snapshot version.

2. web.xml

You need to include the Geomajas GWT service to assure the GWT files can be found. The servlet mapping has to be edited to match your module class’s fully qualified name (example here from the geomajas-gwt-simple module).
Example 3.4. GWT servlet definition

```xml
<servlet>
    <servlet-name>GeomajasServiceServlet</servlet-name>
    <servlet-class>org.geomajas.gwt.server.GeomajasServiceImpl</servlet-class>
</servlet>

<servlet-mapping>
    <servlet-name>GeomajasServiceServlet</servlet-name>
    <url-pattern>/mypackage.GeomajasSimple/geomajasService</url-pattern>
</servlet-mapping>
```

3. Build steps

The GWT compilation needs to be added as one of the build steps. You will need to update the module class and the i18nConstantsWithLookupBundle to match your application.

Example 3.5. GWT compilation

```xml
<plugin>
    <groupId>org.codehaus.mojo</groupId>
    <artifactId>gwt-maven-plugin</artifactId>
    <version>1.2</version>
    <configuration>
        <inplace>true</inplace>
        <module>mypackage.GeomajasSimple</module>
        <runTarget>index.html</runTarget>
        <warSourceDirectory>war</warSourceDirectory>
        <disableCastChecking>true</disableCastChecking>
        <disableClassMetadata>true</disableClassMetadata>
        <extraJvmArgs>-Xmx512M -Xss1024k</extraJvmArgs>
        <i18nConstantsWithLookupBundle>
            mypackage.client.i18n.Simple
        </i18nConstantsWithLookupBundle>
    </configuration>
    <executions>
        <execution>
            <id>test</id>
            <goals>
                <goal>clean</goal>
                <goal>compile</goal>
                <goal>generateAsync</goal>
                <goal>test</goal>
            </goals>
        </execution>
        <execution>
            <id>i18n</id>
            <phase>generate-resources</phase>
            <goals>
                <goal>i18n</goal>
            </goals>
        </execution>
    </executions>
</plugin>
```
4. HTML page

The HTML page should at least contain the following content:

```html
<!DOCTYPE HTML>
<html>
  <head>
    <!-- meta name="gwt:property" content="locale=en" -->
    <link rel="stylesheet" href="geomajas.css">
    <title>GWT web application using Geomajas</title>
    <!-- Name defined in the module xml (=geomajas). -->
    <script type="text/javascript" language="javascript">var isomorphicDir = "mypackage.GeomajasSimple/sc/";</script>
    <script type="text/javascript" language="javascript" src="mypackage.GeomajasSimple/mypackage.GeomajasSimple.nocache.js"></script>
  </head>
  <body>
    <!-- OPTIONAL: include this if you want history support -->
    <iframe src="javascript:''" id="__gwt_historyFrame" tabIndex='-1' style="width:0;height:0;border:0"></iframe>
  </body>
</html>
```

This includes the compiled module script, the SmartGWT isomorphicDir setting and the stylesheets. You should use an HTML5 standard header if you want SVG support in IE9. Other headers will work as well but will result in VML being used for IE. You may need to add conditional headers for other IE versions when using standards mode, but this will depend on the application and is beyond the scope of Geomajas.
Chapter 4. GWT widgets

This second chapter of the GWT face describes all the widgets that Geomajas has added on top of the SmartGWT widget list. Each widget will be handled in detail so that developers might get a better understanding of what they are here for, and how to use them. Know that many of these widgets are closely connected, either through configuration or coding.

1. GraphicsWidget

The GraphicsWidget is the basic widget that allows drawing onto a GraphicsContext, and catches mouse events at the same time. It implements the MapContext interface and provides its own MenuContext implementation. As for the VectorContext, it delegates to a browser specific implementation (VmlGraphicsContext orSvgGraphicsContext). It is also responsible for handling GraphicsControllers (only one global controller at a time!). The reason to place the controller handling here, is because we needed a default GWT widget to handle the events, not a SmartGWT widget. The SmartGWT events do not contain the actual DOM elements for MouseEvents, while the default GWT events do - for some functionality it is absolutely vital that it is well-known which DOM node was the target of an event.

Using the MenuContext, this widget always has the coordinates of the latest right mouse click. Usually the right mouse button is used for drawing context menus. But sometimes it is necessary to have the DOM element onto which the context menu was clicked, to influence this menu. That is why this widget always stores this latest event (or at least its DOM element id, and screen location).

This widget is the bridge between the internal Svg or Vml rendering in GWT and the SmartGWT widget library. It is used internally in the MapWidget, but is not meant to be used directly by developers.

2. MapWidget

The main map for any Geomajas application using the GWT face. This widget controls the MapModel, the MapView objects, has an internal GraphicsWidget for the actual rendering, and much more. Being the most central of all widget, the MapWidget has quite a few responsibilities and options.

Map - initialization

A first responsibility of the map is the correct initialization of its model and all layers from the configuration. When the MapWidget is added to the HTML (onDraw), it will automatically fetch the configuration from the server, and than initialize itself (more precisely, build the MapModel). When this is done, the MapModel will fire a MapModelEvent. Many other widgets wait for this moment to initialize themselves, as they often require the MapModel's contents.

View - rendering

A second responsibility lies in the ability to render shapes. The render() method uses a PainterVisitor to recursively go through Paintable objects and look for the correct Painter. All Painter definitions must be registered in the MapWidget, by means of the registerPainter() and unregisterPainter() methods. Also the full list of WorldPaintables is stored within the MapWidget. For more information regarding the rendering, using the render method, visit the rendering manual.

As an addition of the Paintable objects in screen-space, the definition of a MapAddon has been created as well. MapAddons are self regulating pieces of software that are visible at a certain location on the map (in screen space!), and optionally have attached behaviour. Examples are the Navigation buttons and the scale bar.
To add interactivity to a map, you can add two types of controllers: the GraphicsController and the GWT MouseWheelHandler. For both it is possible to apply a single instance using the setController() and setMouseWheelController() methods.

Options

On top of the previous list of responsibilities, the map also has a few options that allow certain functionality to be present or not. The following options are standard:

• navigationAddonEnabled: this option can be configured from within the configuration, and determines whether or not the navigation MapAddon is visible. This MapAddon is placed in the upper left corner of the map and allows the user to pan, zoom in and out, and zoom to maximum extent.

• scaleBarEnabled: this option can be configured from within the configuration, and determines whether or not the scale bar is visible. This shows you the scale of the map by means of a bar of certain length, expressed in the preferred unit type (metric versus English).

• zoomOnScrollEnabled: this option determines whether or not the ZoomOnScrollController is active by default. This allows zooming in and out on the map using the mouse wheel.

Figure 4.1. MapWidget example

3. OverviewMap

The overview map is an extension of the MapWidget, which keeps the overview of a target MapWidget. It keeps track of the target map's view, and reacts whenever that target map changes it's view. The OverviewMap implements theMapViewChangedHandler to track the changes of it's target map. As it is an extension of a normal MapWidget, it has all the functionality of a normal map. So you can configure layers for an overview map, just as you would for a normal map.
What can be tricky is to properly configure the bounds of the overview map. In the image above, this is slightly bigger than the world (which in this case is probably not what you want). The bounds for the overview map normally uses the initial bounds as defined on the map. However, when you set the useTargetMapMaxExtent parameter to true when creating the overview map, following locations are checked, using the first which was configured:

1. targetMap.maxBounds
2. union of layer extents

The bounds are automatically extended by a percentage. The default is 5%, but this can be configured when creating the overview map.

## 4. Toolbar

The Geomajas toolbar is an extension of the SmartGWT ToolStrip widget, and allows for many different widgets to be added to it. A toolbar must be initialized with an instance of the MapWidget it is related to. When the MapWidget has successfully initialized itself, it's MapModel will fire the MapModelEvent saying so. The toolbar reacts on this event by searching in the map configuration for the correct list of toolbar buttons. The map configuration can contain tool ids to indicate the tools which need to be added, together with optional parameters. Using the ToolbarRegistry, which contains the mappings between these ids and the relevant ToolbarAction or ToolbarModalAction classes, the toolbar will initialize itself (for more info; see User Interaction).

Existing tools which can be defined include:

- **EditMode**: a ToolbarModalAction for editing on the map. Allows the user to create new objects in the selected layer, and allows updating and deleting of selected objects.

- **MeasureDistanceMode**: a ToolbarModalAction which allows the user to measure distances on the map.

- **SelectionMode**: allow selecting features either by clicking on them, or by dragging a rectangle, thus selecting the features which are inside the rectangle. You need an active (vector) layer for the selection to work. The right click menu allows clearing the selected features and toggling selection at the current position. Press shift or control while selecting to add the selection to the previously selected features. Possible parameters:
• **clickTimeout**: when the button it released in less than the number of milliseconds specified here, then the selection is treated as a click. When it takes longer, it is treated as dragging. Default is "500" (ms).

• **coverageRatio**: ratio of the feature which needs to be inside the selected area for the feature to be selected. When this is "1.0" then the entire feature needs to be inside the selection rectangle. Default is "0.7".

• **priorityToSelectedLayer**: when this is "true" selection will first check the selected layer, and use default behaviour only if nothing is found in that layer. Default behaviour is to try all visible layers, from front to back.

• **pixelTolerance**: number of pixels of tolerance allowed when trying to select features. The default pixel tolerance is 5.

• **ZoomIn**: zoom in to the map at the location clicked (will be centered), using the zoom factor which is configured.

  • **delta**: zoom in factor, should be >1 to effectively zoom in.

• **ZoomOut**: zoom out of the map at the location clicked (will be centered), using the zoom factor which is configured.

  • **delta**: zoom in factor, should be in the \([0,1]\) range to effectively zoom out

• **PanMode**: this action allows you to pan the screen by dragging. When keeping either the shift or control key down, it is also possible to indicate an area to zoom into (like ZoomToRectangleMode).

• **ZoomToRectangleMode**: you can indicate a rectangle (by dragging) and it will zoom to make the selected area as big as possible while still entirely inside the map widget.

• **ZoomToSelection**: first select some items on the map. After clicking on the the zoomToSelection button the map will be zoomed so that all selected items will fit nicely on the screen.

• **panToSelection**: first select some items on the map. After clicking on the panToSelection button the map will be panned in such a way that the center of the selected items is in the center of the screen.

• **ZoomPrevious**: go back to the previous zoom level (and location).

• **ZoomNext**: go forward again, cancelling a click on ZoomPrevious.

• **ScaleSelect**: scale select drop-down box.

  • **precision**: precision of the scale. For example using 1000 as precision ensure the value "1:12,345" is displayed as "1:12,000".

  • **significantDigits**: maximum number of significant digits to display in the scale. For example using 3 as value ensures that "1:1,234,567" is displayed as "1:1,230,000".
5. LayerTree

This widget represents a view on the map model which is focused on layers. You see the map layers in a tree, just as they are configured. Accompanied with this view, there are buttons that define certain actions on these layers. Originally there are no buttons in this widget, so they have to be added manually or through configuration. These buttons can either be single actions or selectable buttons (similar to the Toolbar widget - see User Interaction).

Just like the tool bar, the LayerTree waits for the MapModel to be initialized, and also reacts to the MapModelEvent. The layer tree configuration is contained in the map configuration. When the MapModelEvent is fired, the LayerTree will read configuration to know the layer tree structure, which buttons to include,...

Below you see a screen shot of a simple LayerTree where no layer has been selected (and thus all the buttons are disabled):

**Figure 4.4. LayerTree example**

Once a layer is selected, the LayerTree will ask all buttons whether they should be enabled for that layer. For example, the
org.geomajas.gwt.client.action.layertree.LabelAction, which toggles a layer's labels, is only applicable on vector layers, so if the selected layer is a raster layer, that button will remain disabled. The same LayerTree with a selected layer looks like this:

**Figure 4.5. LayerTree with selected layer**

The LayerTree has few public methods, but it does quite a lot behind the screen. The tree is a SmartGWT TreeGrid, where the LayerTree adds handlers to the nodes and leaves (using LeafClickHandler and FolderClickHandler), which trigger layer selection in the MapModel. The LayerTree also listens to layer selection events, to adjust its own appearance. For example, when a layer is selected, the proper node has to be selected and all the buttons updated.

The LayerTreeAction and LayerTreeModalAction are also specifically designed to cope with the different stages that they should be able to display. The LayerTreeModalAction can be disabled, enabled and selected or enabled and deselected. For each it is imperative that clear markings are given. This means that different icons are usually used for the different stages. These different icons should be given to the actions at construction time.

Currently the following actions are defined:

- **org.geomajas.gwt.client.action.layertree.VisibleAction**: a LayerTreeModalAction that switches the visible flag on the selected layer.

- **org.geomajas.gwt.client.action.layertree.LabelAction**: a LayerTreeModalAction that switches the display of labels for the selected layer.

- **org.geomajas.gwt.client.action.layertree.LayerRefreshAction**: a LayerTreeAction that refreshes the selected layer on click.

### 6. Legend

The Legend is a graphical widget that shows all styles for the currently visible vector layers. In that sense it is another view on the map model that only shows the style definitions that are currently relevant. Just like the map widget, the legend is built on GraphicsWidget. It reads the available layers from the map model and draws a legend to match the style of these layers.
7. **FeatureListGrid**

The **FeatureListGrid** is a table listing the attributes of features within a single vector layer. Each feature is represented by a row in the grid, with at the top a header that shows the attribute label, as configured in the configuration. As only vector layers can contain features, the grid will be empty for raster layers.

The **FeatureListGrid** has a few options that determine its behaviour and appearance:

- **selectionEnabled**: enables or disables selection of features when selecting a row in the table. When this is enabled, the table will keep feature selection consistent with the map model. If the user selects a row, the feature will also be selected on the map.

- **allAttributesDisplayed**: show all attributes (true) or only the 'identifying' attributes (false)? Attributes can be configured as "identifying" in the configuration. This difference allows for a select list of attributes to be visible in the grid, keeping overview. The user can always ask more details by double clicking the line.

- **editingEnabled**: determines whether or not editing the attributes is allowed. When double clicking a row in the table, a **FeatureAttributeWindow** will appear, containing the feature of the selected row. This setting determines if that window allows editing or not.

- **idInTable**: show the feature's id in the table. This is false by default, and should not really be necessary.

This table is an extension of the **SmartGWT ListGrid** widget. It automatically has grouping, filtering and sorting abilities (and much more...). The **FeatureListGrid** makes it possible to easily display features. You have to set the layer from which to display features. Then you can add features one by one. If no layer is set, then then "addFeature" method will not add any rows to the table. Setting the layer will automatically create the grid header, using the layer's attribute definitions.
The FeatureAttributeWindow is a floating window to display and enable editing of a feature's attributes and persist these changes. This widget is a FeatureAttributeEditor with some extra buttons like "save". When setting a feature, it first makes a clone so you are not editing the feature directly and changes are only applied when the save is clicked. This widget also checks whether or not all fields are valid, and will not allow saving when at least one of the fields is not valid.

The FeatureAttributeWindow has the following options:

- `editingAllowed`: is editing allowed? This must be set before the widget is actually drawn.
- `editingEnabled`: is editing currently enabled or not? This widget can toggle this value on the fly. When editing is enabled, it will display an editable attribute form with save, cancel and reset buttons. When editing is not enabled, these buttons will disappear, and a simple attribute form is shown that displays the attribute values, but does not allow editing. This effect only works when `editingAllowed` is true.

Below is a screen shot of a FeatureAttributeWindow with editing allowed but not enabled. Without the editing allowed, there would be now "edit" button. The button itself triggers setting editing enabled.
9. ActivityMonitor

This widget monitors client-server communication traffic, and displays that activity to the end-user. Its purpose is inform the user that a server request is in progress. For example, when the user zooms in, it can sometimes take a few seconds before everything is redrawn. This widget displays that traffic by listening to the GwtCommandDispatcher events. On the screen shot below, you can see the difference between it being passive and active:

![ActivityMonitor example](image)

10. ScaleSelect

Combo box for changing the scale on the map which can be added to a tool bar. It displays a list of possible scales to choose from, but also allows the user to type a specific scale. The scale select is constructed with a MapView as parameter. If this MapView contains pre-configured resolutions (zoom-steps - these can be set in the configuration), than the scale select will allow selection from these scales. If no resolutions are present, the scale select will automatically choose relevant scales to choose from.

Using the setScales() method, one can always override the list of scales in the widget.

The setPrecision() and setSignificantDigits() methods allow you to configure the rounding which is applied on the displayed scale values.
11. FeatureSearch

Widget that supports searching for features on the attributes. Requires a value for `manualLayerSelection` at construction time. If true, a select box will be shown so the user can select what layer to search in. The possible list of layers consists of all the vector layers that are present in the map model. If false, this widget will search in the currently selected layer.

When the "search" button is indicated, the search will be performed server-side. When the result returns, a `SearchEvent` is fired. This event holds a reference to the `VectorLayer` in which the search took place, and a list of all the features that were found. In order to do something with the results (such as displaying in a `FeatureListGrid`), add a `SearchHandler`. For the specific case of displaying the feature in a `FeatureListGrid`, there is a `DefaultSearchHandler` that already does this.

Note that there is a limit to the number of features that are returned. By default this limit is set to 100. Modify `maximumResultSize` to change this. Note that a high limit can have a serious impact on performance and memory consumption!

Figure 4.11. FeatureSearch example
Chapter 5. How-to

1. How to set the size of feature attribute windows

By default, the size of the feature attribute windows are determined automatically.

If your features have a lot of attributes this may not be ideal. You can force the size of the feature attribute windows using the WidgetLayout class. Add something like the following in your GWT entrypoint class:

```java
public void onModuleLoad() {
    // force a fixed height to feature attribute windows,
    // preventing them from becoming too big
    WidgetLayout.featureAttributeWindowHeight =
        Window.getClientHeight() - WidgetLayout.windowOffset * 4;
    WidgetLayout.featureAttributeWindowWidth = 470;
    ....
}
```

2. How to assure something is done once the map is initialized

When your application starts, you may need to wait until the map is initialized. For example, trying to read the available layers or access them only works once the map initialization is finished. To avoid the need to write boilerplate code, you can use the runWhenInitialized method. For example, to apply certain bounds, you can use:

```java
final MapModel mapModel = mapWidget.getMapModel();
mapModel.runWhenInitialized(new Runnable() {
    public void run() {
        final Bbox initialBounds = new Bbox(mapModel.getMapInfo().getInitialBounds());
        mapModel.getMapView().applyBounds(initialBounds, ZoomOption.LEVEL_FIT);
    }
});
```

Note that this really only runs once. If the change needs to be applied each time the map is reconfigured (for example when the login token changes), then you should use addMapModelChangedHandler instead.
Appendix A. Migrating between GWT face versions

1. Migrating between GWT face 1.10.0 and Geomajas GWT face 1.11.0

   • Default zoom behaviour for zooming to a selected point has changed: before it was keeping the current scale, now it zooms to the maximum scale (by default). The zoom scale for zooming to points can be changed on a per-layer level by assigning the `zoomToPointScale` property in `ClientLayerInfo`.

2. Migrating between GWT face 1.11.0 and Geomajas GWT face 1.12.0

   • The smartgwt version has upgraded from 2.5 to 3.1. There is a backwards compatibility issue in smartgwt 3.0, see http://www.smartclient.com/smartgwt/release_notes.html#3_0. Although we re-introduced `CloseClientEvent` as deprecated, you might run into problems with `CloseClientHandler`. 